NACE Cathodic Protection Tester Written Exam NACE-CP1-001

Exam Preparation Guide
March 2018

NACE INTERNATIONAL INSTITUTE

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Introduction

The Cathodic Protection Tester (CP 1) written exam is designed to assess whether a candidate has the requisite knowledge and skills that a minimally qualified Cathodic Protection Tester must possess. The exam consists of 98 multiple-choice questions that are based on the entry level Cathodic Protection body of knowledge which is common in the CP industry.

Test Name	NACE- Cathodic Protection Tester written Exam
Test Code	NACE-CP1-001
Time	2 ½ hours*
Number of Questions	98
Format	Computer Based Testing (CBT)

NOTE: A pass/fail grade is provided at the end of the exam.

Exam time includes 4 minutes for the non-disclosure agreement and 6 minutes for the system tutorial.

Target Audience

Candidates for Cathodic Protection Tester (CP 1) should ideally have entry level knowledge of corrosion theory, CP concepts, the types of CP systems in common use, and basic field measurement techniques and equipment. However, CP Tester candidates can range from persons new to the cathodic protection industry with little or no CP field experience to experienced testers, technicians or engineers with some level of cathodic protection skill. Typically, Cathodic Protection Testers are responsible for testing and recording the effectiveness of operating cathodic protection systems and/or assisting in the installation of new CP systems or components under the direction of experienced CP personnel.

Requirements

Cathodic Protection Tester (CP1)

Requirements for Cathodic Protection Tester (CP 1):

- 2 Core Exams

Work Experience Requirements
No previous work experience required
Core Exam Requirements
The following exams are required: (2 core exams required)
Cathodic Protection Tester (CP 1) exam (practical / hands on) Cathodic Protection Tester (CP 1) closed book exam (multiple choice, with relevant references)- NACE-CP1-001

Note: Completion of course does not entitle the candidate to the certification.

Note: The Cathodic Protection Tester (CP 1) practical / hands on exam is given at the conclusion of the NACE Cathodic Protection Tester (CP 1) course.

Certification renewal requirements – Recertification application*

- A minimum of 1.5 years of cathodic protection work experience
- A completed re-certification Application
- A minimum of 24 Professional Development hours

Upon successful completion of requirements, the candidate will be awarded a **Cathodic Protection Tester (CP 1) Certification**

**Approval required*

Next Level of Certification:

Cathodic Protection Technician (CP2)

CP1 – Knowledge and Skill Areas Tested

NOTE: At the end of the CBT exam the candidate will receive a bar chart of strengths and weaknesses that correspond to these Domains.

Domain 1- Basics - 30-32%

- Understand the relationship between voltage, current and resistance as expressed by Ohm's Law.
- Understand basic DC circuits, including series, parallel and series-parallel.
- Understand the application of Kirchhoff's electrical circuit laws.
- Understand the composition of a basic galvanic cell and the electro-chemical reactions that allow corrosion to occur at the anode rather than the cathode.
- Understand the cause and effect of polarization in a galvanic cell.
- Understand the concept of cathodic protection and the two primary methods of applying it to metal objects underground or otherwise immersed in an electrolyte.
- Understand how corrosion cells are formed on metal objects that are underground or otherwise immersed in an electrolyte.
- Understand the physical and chemical characteristics of metal and electrolytes that affect corrosion rates.
- Understand the characteristics and application methods of common pipeline coatings.
- Understand the concept of shielding and how it can affect metallic objects that are cathodically protected.
- Understand the use of Faraday's first law in relation to cathodic protection and corrosion of metals.
- Understand the causes and types of AC interference (or interactions) with pipelines and related safety standards and safe work practices.
- Understand safety considerations and methods for dealing with spark hazards and current in piping.

Domain 2- Atmospheric- 1-2%

- Perform periodic atmospheric corrosion inspections and document your findings according to accepted industry practice.

Domain 3- Insulators and Shorts (Electrical Isolation and Metallic (Electrical)) - 8-10%

- Understand the use of for electrical isolation between facilities.
- Understand the use of protective devices for isolation devices.
- Understand the effect a metallic short can have on a CP system.
- Test to see if an isolation device is shorted using pipe-to-soil potential readings.
- Test an isolator with an electronic isolation checking instrument.
- Understand methods used to locate and clear shorts on an underground pipeline system.

Domain 4- Instruments - 24-26%

- Understand the operation of digital and analog Volt-Ohm meters (multimeters) and how they are used to measure current, voltage and resistance.
- Understand the operation of a soil resistivity meter.
- Use a digital Volt-Ohm meter to determine the current output of sacrificial anodes installed on your system.
- Conduct a soil resistivity test with a Vibroground, Nilsson or equivalent instrument.
- Conduct soil resistivity measurements by using a Soil Box.
- Conduct single-point soil resistivity readings with a "Collins Rod".
- Install interrupters in rectifiers or bonds for the

purpose of taking and "On" and "Instant off" structure-to electrolyte potential readings.
- Understand the various types of pipe locating instruments and be able to utilize them to locate pipelines or cables in all underground environments.
- Understand the methods and equipment for testing pipeline coatings for holidays (damage) before burial.

Domain 5- CP Current Source - 12-14%

- Understand the different types of impressed current and galvanic anodes and how they are installed in soil and water environments.
- Install galvanic and impressed current anodes, document the installation and test to insure proper operation.
- Use a digital Volt-Ohm meter (multimeter) to determine the voltage and current output of a rectifier and the condition of diodes.
- Understand a simple transformer-rectifier circuit and be able to follow the input AC voltage through the transformer to the rectification stack and the DC from the stack to the load.
- Understand the causes of common abnormal CP circuit conditions and their resulting effects on rectifier DC output.

Domain 6 - CP Test Leads - 4-6%

- Install test leads for a potential test station according to common industry practice.
- Install jumper test leads across an isolation flange according to common industry practice.
- Install test leads for an interference bond according to common industry practice.
- Install test leads for a line current test station in order to measure current flow in a pipeline.
- Install test leads for a foreign line crossing.
- Understand the common methods of making test lead and cable attachments to structures.
- Make test lead and cable attachments to a pipeline or tank by using an exothermic weld kit.
- Make repairs and/or splices to bond leads, header cables and test leads.

Domain 7- Shunts - 4-6%

- Understand how to determine the amount of current flowing through various size shunts by reading the milli-Volt (mV) drop across it with a Volt-Ohm meter and applying the correct conversion factor.
- Understand how to determine the direction of current flow through a shunt by observing the polarity of the mV reading.
- Read shunts in rectifiers to determine the output current.
- Read shunts in bonds with foreign structures.
- Read shunts for individual anodes associated with impressed current ground beds.
- Utilize an external shunt to determine the output current of a rectifier with a broken amp meter.
- Read shunts that are installed in galvanic anodes to determine the output of current.

Domain 8 - Periodic Surveys - 5-7%

- Conduct annual pipe-to-soil potential surveys on all facilities.
- Conduct rectifier readings.
- Conduct surveys of bonds.
- Conduct soil resistivity surveys.
- Conduct cell-to-cell surveys.
- Collect data on external "coupon test stations".
- Conduct offshore platform and riser surveys.

Domain 9 - Reference Cells - 6-8%

- Understand the construction and operation of reference cells and maintain them in a manner that will provide comparative readings.
- Install permanent (stationary) reference cells and check them periodically to insure they are in good working order.

- Understand recommendations in the MSDS sheet pertaining to the handling and disposal of Copper Sulfate.
- Use and understand the different types of reference cells and their related conversion factors.
- Use an antimony half-cell in comparison to a copper/copper sulfate half-cell for determining the pH of soils.

Domain 10 - Record Keeping and Administrative - 1-2%

- Record readings from periodic surveys and other inspection and maintenance according to common industry practice.
- Maintain records required by respective regulations for the life of the facility involved.
- Understand the importance of accurate facility records, drawings, such as pipeline alignment sheets and other system maps, and be able to provide accurate locations where work was done or new facilities installed.

Types of Questions

Description of Questions

The questions on this exam are multiple-choice and there is only one correct answer per question. The questions are based on the knowledge and skills required in the cathodic protection industry for a Cathodic Protection Tester. While the NACE training course is an excellent method of preparation, it is not the only reference used in the development of the questions. Additional references can be found in the Reference section.

Sample Questions

The sample questions are included to illustrate the formats and types of questions that will be on the exam. Your performance on the sample questions should not be viewed as a predictor of your performance on the actual test.

1. Polarization of a metal
   a. Causes corrosion
   b. Reduces corrosion rate
   c. Increases corrosion rate
   d. Increases the amount of current

2. Which of the following are advantages of impressed current systems?
   a. No external power is required
   b. Flexible voltage and current outputs
   c. Less susceptible to damage from lighting
   d. No routine inspections required

3. Which of the following data are used to determine when adequate cathodic protection is achieved?
   a. Rectifier output voltage
   b. Resistance of impresses current anode groundbeds
   c. Current output of galvanic anodes
   d. Structure-to-electrolyte potentials

4. The primary source of information about chemical hazards can be obtained form
    a. Product data sheet
    b. Code of federal regulations
    c. Material Safety Data Sheet
    d. Equipment schematics

Answer Key

1. **B**

Reference: NACE Cathodic Protection Tester (CP 1) Course Material

2. **B**

Reference: NACE Cathodic Protection Tester (CP 1) Course Material

3. **D**

Reference: NACE Cathodic Protection Tester (CP 1) Course Material

4. **C**

Reference: NACE Cathodic Protection Tester (CP 1) Course Material

Preparation

Training

NACE Cathodic Protection Tester – CP1 Course

Latest editions should be used for all standards. Certain content from these standards are incorporated in the NACE Cathodic Protection Tester (CP 1) course materials and some of them are included in the course manual.

Suggested Study Material

- NACE Cathodic Protection Tester (CP1)- Course materials

To take the NACE Cathodic Protection Tester (CP 1) exam without taking the NACE Cathodic Protection Tester (CP 1) course, the following materials are recommended for review. The exam covers certain information that is contained in these documents.

Books

- Peabody, A.W. (2001), Control of Pipeline Corrosion, Second edition. NACE International, the Corrosion Society.

Papers

- Ansuini, Frank J., James R. Dimond, "Factors Affecting the Accuracy of Reference Electrodes", Materials Performance, 33, 11 (1994): pp. 14-17.

Standards

Latest editions should be used for all standards. Certain content from these standards are incorporated in the NACE Cathodic Protection Tester (CP 1) course materials and some of them are included in the course manual.

- SP0169 Control of External Corrosion on Underground or Submerged Metallic Piping Systems
- SP0285 Corrosion Control of Underground Storage Tank Systems by Cathodic Protection
- SP0388 Impressed Current Cathodic Protection of Internal Submerged Surfaces of Carbon Steel Water Storage Tanks
- SP0177 Mitigation of Alternating Current and Lightning Effects on Metallic Structures and Corrosion Control Systems
- SP0575 Internal Cathodic Protection (CP) Systems in Oil-Treating Vessels
- SP0176 Corrosion Control of Submerged Areas of Permanently Installed Steel Offshore Structures Associated with Petroleum Production
- RP0193 External Cathodic Protection of On-Grade Carbon Steel Storage Tank Bottoms
- SP0196 Galvanic Anode Cathodic Protection of Internal Submerged Surfaces of Steel Water Storage Tanks
- SP0290 Impressed Current Cathodic Protection of Reinforcing Steel in Atmospherically Exposed Concrete Structures
- SP0200 Steel-Cased Pipeline Practices"
- TM0497 Measurement Techniques Related to Criteria for Cathodic Protection on Underground or Submerged Metallic Piping Systems
- TM0101 Measurement Techniques Related to Criteria for Cathodic Protection of Underground Storage Tank Systems

Other

- American Water Works Association (AWWA)

  Standard D104 "Automatically Controlled, Impressed Current Cathodic Protection for the Interior of Steel Water Tanks."

- American Petroleum Institute (API)
  Recommended Practice 651, "Cathodic Protection of Above Ground Petroleum Storage Tanks.

  Recommended Practice 1632, "Cathodic Protection of Underground Petroleum Storage Tanks and Piping Systems."

- U.S. Government, Code of Federal Regulations (CFR)

  49CFR Part 192, Subpart I Natural Gas Pipelines

  49CFR Part 193, Subpart G Liquefied Natural Gas

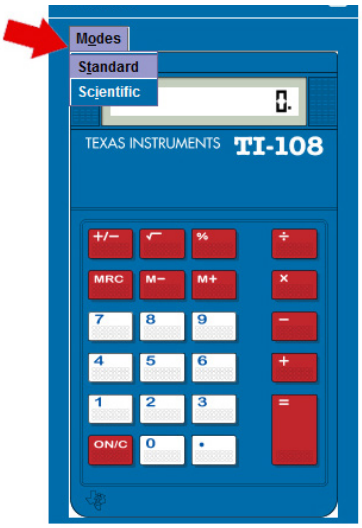
  49CFR Part 195, Subpart D Hazardous Liquid Pipelines

  40CFR Part 280 Underground Storage Tanks

Calculators

Students will have access to either a TI Standard or TI Scientific calculator for use during the CBT Exam.

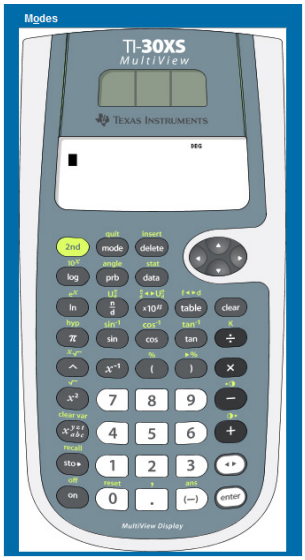
Standard Calculator



Standard Mode Functions

Add	+	
Subtract	-	
Multiply	X	
Divide	÷	
Negative	(-)	
Percentage	%	
Square Root	√	Example: 4 √
Reciprocal (Inverse)	x	Example: 1 ÷ 2 =
Store value to variable	M+	Example: 3 * 5 = M+
Access variable	MRC	Example: 7 + MRC =
Clear variable	M- MRC	

Scientific Calculator



Scientific Mode Functions

Add	+	
Subtract	-	
Multiply	X	
Divide	÷	
Negative	(-)	
Percentage	2nd [%]	
Square Root	√	Example: 2nd √ 4 enter
Reciprocal (Inverse)	X^{-1}	Example: 2 X^{-1} enter
Store value to variable	sto▶ X^{yzt}	Example: 3 * 5 enter sto▶ X^{yzt} enter
Access variable	X^{yzt} or 2nd [recall]	Example: 7 + 2nd [recall] enter enter

Numeric Notation

Standard (Floating Decimal) Notation (digits to the left and right of decimal	mode menu options **NORM** SCI ENG FLOAT 0 1 2 3 **4** 5 …	 e.g. 123456.78 e.g. 123456.7800
Scientifi Notation (1 digit to the left of decimal and appropriate power of 10)	mode menu options NORM **SCI** ENG	 e.g. 1.2345678*105
Engineering Notation (numer from 1 to 999 times 10 to an integer power that is a multiple of 3)	mode menu options NORM **SCI** ENG	 e.g. 123.45678*103

Fractions

Simple fractions	n/d
Mixed numbers	2nd [Un/d]
Conversion b/w simple fraction and mixed number	2nd [n/d ◄► Un/d]
Conversion b/w fraction and decimal	2nd [f ◄► d]

Powers, roots, and inverses

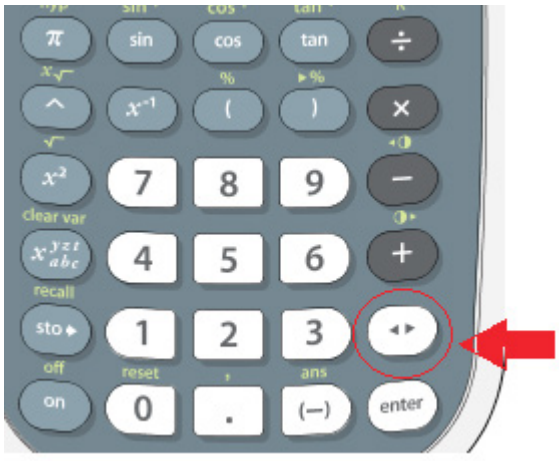
Square a value	x^2	
Cube a value	^	
Raise value to specified power	^	Example (2^4) 2 ^ 4
Square root	2nd [√]	Example (√16): 2nd [√] 16
Reciprocal	x^{-1}	Example (n^{th} root): 5^{th} root of 8: 5 2nd [^{x}√] 8

Pi

PI (π)	π

Toggle

The scientific calculator might show the results of certain calculations as a fraction - possibly involving pi or a square root. To convert this kind of result to a single number with a decimal point, you will need to use the "toggle answer" button circled in the picture below. Pressing this button will change the display from a fractional to a decimal format.



Answer Toggle

Press the ◄► key to toggle the display result between fraction and decimal answers, exact square root and decimal, and exact pi and decimal.

Example

Answer toggle	2nd [√‾] 8 enter	√8 → 2√2
	◄►	√8 / 2√2 → 2.828427125

If you find this onscreen calculator difficult to use, raise your hand and ask the TA to provide you with a hand-held calculator. **If available**, you will be provided with a scientific or non-scientific calculator. Candidates are not permitted to bring their own calculator into the testing room.

Reference Material Provided During the Exam

Candidates will not have access to the full manual during the exam however targeted reference material will be available in the testing system. This material is provided during the exam to aid in answering questions. No outside material is permitted during the CBT exam.

- Conversions

  US to metric
  Volts
  Ampere
  Ohms
  meter

- Symbol definitions

  EMF
  E or e
  V or v
  mV or mv
  µV ar µv
  I or i
  mA or ma
  µA or µa
  R, r or Q

- Formulas

  Resistivity
  OHMS Law
  Power
  Series Circuits
  Parallel Circuits
  Area of a Circle
  Surface area of a Cylinder
  Faraday's Law
  4-Wire Line Current Test Calibration Factor

- Tables and Figures

  4-Wire Line Current Test Calibration Factor
  Steel Pipe to Resistance
  Color Code for Resistors
  Rectifier Circuit
  Practical Glavanic Series
  Electrochemical Circuits
  Structure-To-Electrolyte Potential
  SP0169 Criteria